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ELLIS L. MICHAEL AND HIS SCIENTIFIC WORK

Mr. Michael was born at La Porte, Indiana, August 26, 1881, and died at La Jolla, California, August 30, 1920.

His undergraduate college education was obtained at the University of Michigan, and his more advanced student work was done at Leland Stanford Jr. University and at the University of California, chiefly at the latter.

Although his chief interest and work as a graduate student were in zoology, his natural bent for the quantitative side of nature manifested itself while he was an undergraduate, by his having chosen more mathematical courses than is the wont of students who incline to general zoology or botany.

Wholly dependent upon his own resources, after graduating from the University of Michigan, and giving himself the benefit of a season or two at that mecca of American biologists, the Marine Biological Laboratory at Woods Hole, Mr. Michael found his way to California. As a graduate student and laboratory assistant at the University of California, he became a participant in the early reconnaissance efforts of the department of zoology in marine work.

His first official connection with what finally grew to be the Scripps Institution for Biological Research, was as "Resident Naturalist" of the laboratory at La Jolla in the years 1905 to 1909. During this period, except for vacation periods of the University, the embryonal La Jolla laboratory was scientifically uninhabited except by the resident naturalist and an occasional visiting naturalist.

Mr. Michael's first serious research as a member of the developing enterprise was on the pelagic group of worms, the Chaetognatha. The detail and accuracy, qualitative and quantitative, with which he described the species of this group occurring in the "San Diego Region" ("Classification and Vertical Distribution of the Chaetognatha of the San Diego Region," Univ. of Cal. Publ. Zool., Vol. 8, 1911) marked him at once as the foremost authority, in America at least, on the taxonomy and distribution of this group. Furthermore, his treatment of the vertical distribution and migrations of these animals contains the first clear setting forth of a group of phenomena, and a method of dealing with them, that seems to be limited only by the boundaries of the entire vast domain of maritime planktology.

At the time of publication of this and other papers by Michael on the movements of chaetognaths as influenced by physical conditions of the sea,

ecology was less clearly defined and less widely cultivated as such than it has since become ; and its basal conceptions had hardly been applied at all to marine life, even though that life had been so long and so fruitfully investigated *ecologically*—as we may now say. My impression now is that had Michael's plankton studies identified themselves earlier and more closely with the ecological development in this country, they would have attracted more attention than they so far have. So confident was Mr. Michael that the "plankton program" of the Scripps Institution, in which program he himself was playing a major part, was developing ideas and methods of first rate importance, that his disappointment at the slight attention which his papers received was rather keen. Hence it was that the recent evidences of interest in his work shown by the officers and members of the Ecological Society were doubly gratifying to him.

But time and the general power of truth can be trusted to take good care of whatever has genuine worth to science and human welfare. Little hesitations and neglects and by-wanderings do not count for much in the long run.

During the last few years of Michael's life, some of his intimate friends and co-workers felt that he was becoming over engrossed in the statistical aspects of the problems at which he worked. It seemed that he showed something of the tendency not uncommon to scientists who apply mathematics to the phenomena of nature—the tendency, that is, to conceive mathematics to have some other power over natural truth than merely that of a tool. But surely his offence in this was not great, if it existed at all. And certain it is that one of his foremost services to ecology and to all biology was in the domain of method, chiefly statistical method. Three of his papers may be pointed to as typifying the character of his work. One of these, the earliest of the three, is that on the chaetognatha already mentioned.

Another is "Differentials in Behavior of the Two Generations of *Salpa democratica* Relative to the Temperature of the Sea," Univ. of Calif. Publ. Zool., Vol. 18, 1918.

In this paper he showed, by a statistical treatment of the extensive quantitative collections of this species made by the Scripps Institution, that the two generations do not react quite the same to depths and temperature. To illustrate, "Solitary forms are most abundant but least frequent in warmer water ;" while "Aggregate forms are most abundant and most frequent in colder water." The methods by which these results were reached are quite as interesting as the results themselves.

The third paper to be mentioned is the recent one by Michael and George F. McEwen, the oceanographer of the Scripps Institution, working in collaboration. ("The Functional Relation of one Variable to Each of a Number of Correlated Variables Determined by a Method of Successive Approximation to Group Averages," Proc. Amer. Acad. Arts and Sciences, Vol. 55, 1919).

The ecological substance of the investigation here reported has been stated thus: "Given the requisite taxonomic knowledge of a natural group (an order, say, with its several genera and species) of pelagic animals, and the requisite facts as to the vertical distribution of these animals through diurnal and annual cycles; and given further the requisite factual knowledge of the temperature, salinity, light, etc., of the waters inhabited by the animals, how do the observed changes of the several environmental elements operate as causal factors in the distribution of the animals, this operation being inferred from such correlation as may be discovered in the two series of quantities, biologic and oceanographic?"

Should the method here described be found trustworthy and practicable it would be highly useful for it would be applicable "to the entire expanse of living nature, because all organisms, man with the rest, are subject to natural environments of some sort, and the very essence of the method is its effort to bring together data pertaining to organisms and their environments."

The significance for ecology, and especially for marine ecology, of Michael's life work, though now recognized as considerable, will, it seems probable, be more clearly and fully seen later on.

But whatever the fruits, now or for the future, of his scientific labors, he left behind a record of industrious, faithful, and honest effort in marine biology broadly conceived, and of devoted official service to the institution with which his entire professional career was identified. His going leaves a breach in the staff of the institution and in its program of marine ecology that will not be easy to fill.

Of the personal qualities which gained for him the respect and friendship of his neighbors and professional associates, it is not the province of a note like this to dwell upon.

In accordance with the expressed wish of Mr. Michael, the bodily remains were cremated. And by a happy thought of his father, who is also connected with the Scripps Institution, the ashes were given to the waters of the Pacific, the commitment taking place at the end of the pier where much of the field work of the Institution's marine program is carried on.

That the wholly informal event of disposing of the ashes was a solemn and impressive one to the few of his close friends and fellow-workers present, hardly needs saying. But the solemnity was strongly heartened by reflections induced by our act on the common lot of us all, not only as to the transitoriness of our lives, but likewise as to our oneness with the infinite frame and spirit of the universe.

WILLIAM E. RITTER

